Belvoir Castle in Leicestershire and 2.7 degrees below at Newquay, up to only 0.5 degree below normal at Castle Bay in the Hebrides. Except in December, the cold was general over western Europe with the mean temperature of Sweden 1.9 degrees below, of Holland 2.7 degrees below, and of Norway 1.5 degrees below their respective normals; while as far south as Gibraltar the mean was 1.1 degrees below the average. It was shown that when the eastern portions of the British Isles had a mean temperature below the normal in each month from December to April—an event that had occurred only five times during the last century and a half—there was then a pronounced tendency for the depression of temperature to continue without interruption until the end of the year. The only exception occurred in 1808, when a warm period covering the four months from May to August was sandwiched in between two cold spells. The frequent absence of historic frosts during long periods of uniform cold over the British Isles was also referred to.

ACCIDENTAL PRESSURE VARIATIONS IN THE UNITED STATES.

By ALFRED J. HENRY, Professor of Meteorology.

[Dated: Weather Bureau, Washington, D. C., July 6, 1917.]

A recent article by Dr. A. Defant on the daily, nonperiodic pressure variations in the United States[1] recalls to my mind some work on the same subject on which I was engaged about 12 years ago. This work was undertaken at the suggestion of the late Professor Abbe, who at that time was in correspondence with the Russian meteorlogist Woeïkof [Voeïkov] on the subject of the mean pressure variation in 24 hours. Press of other work prevented the completion of the study as originally planned, and the matter was laid aside for the time. The conclusions reached coincide quite closely with those announced by Dr. Defant, who has considered the mean hourly values as printed in the Annual Reports of the Chief of the U. S. Weather Bureau for 1898 to 1902 (4° edition).

It is convenient to think of the nonperiodic or accidental pressure fluctuations as advancing wavelike from west to east and as standing in close relation to the problem of weather forecasting, hence the very great interest of forecasters in the subject.

It has been known in a general way for many years that the changeable character of the weather on this continent is closely related to areas of rising and falling pressure that move at irregular intervals across the country from west to east. It has occurred to the writer that an examination of these waves of rising and falling pressure might lead to some interesting, if not valuable, results. There are several ways of attacking the problem, depending on the particular object in view.

Both the duration and amplitude of waves of rising or falling pressure can be obtained directly from the barograms, but since this method involves the measurement of a great number of instrumental records, a less precise plan was adopted, viz, that of taking the difference between the 8 a. m. "station pressure"[2] of one day as compared with that of the succeeding day at the same hour, and affixing the proper algebraic sign. This has been done for a period of ten years, 1894–1903, for two stations on the Pacific coast, Portland, Oreg., and San Diego, Cal.; three stations in the Mississippi Valley, St. Paul, St. Louis, and New Orleans; and two stations on the Atlantic coast, Eastport and Key West. The record covers 3,650 days at each station, and shows in detail whether pressure was rising or falling and the amount of the change.

Number of periods of falling pressure and average interval.—The total number of periods of falling pressure for the several months of the year is given in Table 1. If the total number of periods of falling pressure of whatever length be divided into the number of days in the period, the average interval between two successive periods will be found. These data also appear in the table. The geographic coordinates of the stations are as follows:

	Lat. N.	Long. W.
Portland, Oreg.	45° 32′	122° 43′
San Diego, Cal.	32 43	117 10
St. Paul, Minn.	44 58	93 03
St. Louis, Mo.	38 38	90 12
New Orleans, La.	29 58	90 04
Eastport, Me.	44 54	66 59
Key West, Fla.	24 33	81 48

TABLE 1.—*Total number of areas of falling pressure (katallobars),* and average time interval between them, in the 10 years 1894–1903.*

Stations.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average, annual.
Pacific coast.													
Total number:													
Portland, Oreg.	81	83	80	74	78	75	70	85	72	75	82	80	93
San Diego, Cal.	77	66	75	74	72	72	70	72	67	72	71	74	86
Average interval (days):													
Portland, Oreg.	3.8	3.4	3.9	4.1	4.0	4.0	4.4	3.7	4.2	4.1	3.7	3.9	3.9
San Diego, Cal.	4.0	4.3	4.1	4.0	4.3	4.2	4.4	4.3	4.5	4.3	4.2	4.2	4.2
Mississippi Valley.													
Total number:													
St. Paul, Minn.	92	69	80	73	77	70	76	87	80	79	83	82	95
St. Louis, Mo.	88	71	73	71	79	63	70	73	70	73	78	83	89
New Orleans, La.	75	72	70	69	66	64	64	75	67	68	74	75	84
Average interval (days):													
St. Paul, Minn.	3.4	4.1	3.9	4.1	4.0	4.3	4.1	3.6	3.8	3.9	3.6	3.8	3.8
St. Louis, Mo.	3.5	4.0	4.3	4.2	3.9	4.8	4.4	4.3	4.3	4.3	3.8	3.7	4.1
New Orleans, La.	4.1	3.9	4.4	4.3	4.7	4.7	4.8	4.1	4.5	4.6	4.1	4.1	4.3
Atlantic coast.													
Total number:													
Eastport, Me.	88	75	76	75	77	79	72	80	80	84	82	86	95
Key West, Fla.	70	68	65	60	56	64	66	66	59	58	59	62	75
Average interval (days):													
Eastport, Me.	3.5	3.8	4.1	4.0	4.0	3.8	4.3	3.9	3.8	3.7	3.7	3.6	3.8
Key West, Fla.	4.4	4.2	4.8	5.0	5.5	4.7	4.7	4.7	5.1	5.4	5.1	5.0	4.9

* Using the nomenclature of Ekholm.

The results of the compilation show that practically all of the pressure falls (katallobars) pass entirely across the United States from the Pacific to the Atlantic; that is to say, the number entering the continent on the Pacific coast is practically the same as that leaving the continent on the Atlantic coast at Eastport, Me. The average number which passes St. Paul, Minn., in the interior is slightly greater than that which enters the continent over the coasts of Washington and Oregon. The number is somewhat larger at northern than at southern stations, and the maximum for any month generally falls in the winter, although there is the suggestion of a secondary maximum in August, which at Portland, Oreg., becomes the primary maximum.

Duration of katallobars.—Along the northern boundary of the United States falling pressure, in a little more than

[1] *Defant, A.* Die täglichen unperiodischen Druckschwankungen im Gebiete der Vereinigten Staaten von Nordamerika. Meteorol. Ztschr., Braunschweig, November 1916, 33: 503–510. 3 figs.

[2] "Station pressure" for a Weather Bureau station is the corrected pressure for the station a tthe altitude of the station.

50 per cent of the cases, is succeeded by rising pressure after an interval of 24 hours or less; but in the southern part of the country the number of cases of falling pressure continuing for two consecutive days is decidedly greater than in the north. The details for the months of January and July are shown in Table 2, expressed as percentages of the total number of cases. For example, at Portland, Oreg., the interval was 24 hours or less in 46 per cent of the total number of cases; 48 hours or less in 35 per cent of the cases, etc.

TABLE 2.—*Percentage frequency of the intervals stated, between katallobars at the several stations in January and in July (1894–1903).*

Stations.	JANUARY.							JULY.						
	Interval in days.							Interval in days.						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
	P.c.	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*
Portland, Oreg	46	35	12	6	0.5	....	0.5	36	36	18	7	3	0.5	....
St. Paul, Minn	56	32	10	0.5	0.5	0.5	....	50	33	14	2	1	....	....
St. Louis, Mo	55	23	10	11	2	....	....	30	33	19	12	5	0.5	0.5
Eastport, Me	56	31	8	2	2	0.5	....	25	44	18	7	6	....	....
San Diego, Cal	33	37	17	12	0.5	....	0.5	38	39	19	4	....	....	....
New Orleans, La	32	38	19	10	0.5	....	0.5	30	43	24	3	....	....	....
Key West, Fla	33	38	16	1	6	5	0.5	32	43	16	9	1	....	....

The greatest number of consecutive days with falling pressure at any of the stations in the United States was seven; a few cases were recorded where the pressure was either stationary or falling for eight and nine consecutive days, but these cases were rare. When the fall was long continued the amount day by day was small, especially at southern stations. One case was noted, however (Eagle, Alaska, from Dec. 14–21, 1899), where the aggregate fall for eight consecutive days was 1.66 inches. This amount in hundredths of inches was distributed as follows: 0.18, 0.37, 0.20, 0.42, 0.13, 0.25, 0.01, and 0.10.

Mean daily accidental variations.—The mean daily accidental pressure fluctuations, in inches of mercury, for the 10 years are given in Table 3. This table clearly shows that the greatest daily accidental changes in pressure are found off the Maine coast. Additional observations in this region would probably show that even greater fluctuations are the rule over the Grand Banks and the continental districts adjacent thereto.

The amplitude of the variations diminishes from north to south in a striking manner.

TABLE 3.—*Mean daily accidental pressure variations for the 10 years 1894–1903.*

Stations.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
Portland, Oreg	0.17	0.17	0.18	0.15	0.12	0.10	0.08	0.08	0.11	0.13	0.18	0.17
San Diego, Cal	.08	.08	.07	.06	.05	.04	.04	.04	.04	.05	.06	.07
St. Paul, Minn	0.24	0.21	0.23	0.17	0.15	0.12	0.11	0.12	0.16	0.19	0.20	0.23
St. Louis, Mo	.20	.20	.21	.14	.10	.08	.07	.07	.09	.12	.17	.20
New Orleans, La	.13	.14	.12	.08	.05	.04	.04	.04	.04	.06	.08	.12
Eastport, Me	0.33	0.30	0.31	0.20	0.17	0.15	0.13	0.12	0.18	0.23	0.24	0.28
Key West, Fla	.07	.07	.06	.05	.04	.03	.03	.03	.04	.05	.05	.06

In general we perceive from this study that the accidental pressure fluctuations are somewhat more numerous and of greater amplitude in higher than in lower latitudes, and that, as a corollary, the time interval between successive katallobars increases from north to south. All of this is in harmony with the experience of weather forecasters on the North American Continent.

THE TORNADOES AND WINDSTORMS OF MAY 25–JUNE 6, 1917.[1]

551.515 (73)

By H. C. FRANKENFIELD, Professor of Meteorology.

[Weather Bureau, Washington, D. C., July 20, 1917.]

INTRODUCTION.

During the Spring severe local storms may reasonably be expected over some sections of that portion of the United States lying east of the Rocky Mountains, and the years without such severe storms are rare indeed. The conditions leading up to these unwelcome visitations do not occur in such complete form in any other portion of the Northern Hemisphere, but they are clearly defined and are very largely incident to topography. Examine a map of the globe and it will be seen at once that no other portion of the Northern Hemisphere presents a similar arrangement of wide expanse of relatively warm land with, or open to, warm subtropical and tropical waters to the south and southeast and a limiting mountain wall to the westward. At times when certain systems of pressure distribution prevail over the continental interior warm moisture-laden winds from the south and southeast are carried inland and finally encounter the colder north and northwest winds descending along the eastern slopes of the north-and-south barrier. Given these warm south and southeast winds and the cold north and northwest winds, it is apparent that in the region where they meet, and closely adjacent thereto, great interchanges of heat will occur and give rise to phenomena whose intensity will vary with the degree of contrast in the original conditions.

According to Murray, the word "tornado" is evidently of Spanish or Portuguese origin. Its earlier English spelling was *ternado*, probably a corruption of the Spanish *tronada*, or thunderstorm, while *tornado* may have been an attempt to improve *ternado* by treating it as a derivative of the Spanish *tornar*, to turn or return. This spelling is identified with explanations in which not the thunder, but the turning, shifting, or whirling winds are the main features. The sixteenth century navigators applied the term to the violent thunderstorms of the tropical Atlantic with their torrential rains and sudden violent gusts of wind, but this usage is no longer current in the United States.

By tornado we now mean a violent rotary windstorm of restricted diameter, accompanied by rain, and usually by hail, lightning, and thunder. The air masses whirl with great velocity about a central axis, while the whole storm moves along a narrow path across the country with considerable speed, usually between 40 and 50 miles an hour. The width of the path of greatest violence may vary from a few rods to as much as a mile. The tornado cloud is of a black, or ugly gray-black color and usually, although not always, with one or more pendant, funnel-shaped clouds which may or may not reach the earth. The existence of the funnel cloud is entirely in accord with the theory of the tornado and it is not unreasonable to assume that it is always present, but that in instances where it was not observed the main body of the storm cloud swung too close to the earth, cutting off the pendant, or else it may be invisible in the absolute darkness that frequently attends tornadoes.

Tornadoes almost invariably develop in the southeastern quadrant of an area of low pressure, and they may occur at a distance of a much as two or three hundred miles from the center of the depression, originating as a secondary depression in which the ascent of warm and moist air over a region accompanied by a contraclockwise movement of winds directed spirally inward, plays

[1] Accompanied by Charts XLV-59 to XLV-67, inclusive.